drought tips

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Water Quality Guidelines for Trees and Vines

Agricultural soils and irrigation water contain varying amounts and types of salts, but a soil is not considered saline unless the concentration of salts in the crop rootzone is high enough to reduce crop growth and yield. Tree and vine crops are generally more sensitive than field crops to salinity, chloride, sodium, and boron.

Salinity affects tree and vine performance in two ways. First, the plants must acclimate themselves to a saline environment in order for water to become available. This process requires energy the plant normally uses for growth and production. Second, chloride, sodium, and boron can reduce yields because of specific ion toxicity. Sensitive trees and vines can accumulate large concentrations of these elements in leaves, causing leaf burn. The two processes can operate simultaneously and can reduce crop yield.

Salinity Threshold

All tree and vine crops can tolerate some salts in the rootzone without harm to yield or plant quality. The maximum amount of salt the plant can tolerate in the rootzone with reduction in growth or yield is called the "salinity threshold." Beyond this level crop yields are reduced in proportion to the salt concentration in the rootzone.

Irrigation Management

Effective irrigation management is important anytime, regardless of the availability or quality of water, but becomes essential during a drought. After irrigation water and its dissolved salts move into the crop rootzone, the plant extracts "pure water," for the most part, leaving the salts behind. The amount of salt in the rootzone will increase over time unless more water than the crop uses is applied. This excess water controls soil salinity levels by leaching some of the salt from the rootzone. The fraction of applied water that moves downward through the rootzone and is not used by the crop is called the "leaching fraction."

Soil salinity is expressed as the electrical conductivity of the saturated soil extract (ECe) (with the units usually expressed in mmhos/cm and/or dS/m).

Rootzone salinity (ECe) increases as the leaching fraction decreases for a given irrigation water salinity (ECw). Increasing the leaching fraction when using a more saline irrigation water can result in the same average rootzone salinity as using a less saline irrigation water with a lower leaching fraction. In short, if a more saline water must be used because of drought, applying more water to increase leaching can lessen the effects of salinity on plant growth.

Water Quality Guidelines

Table 1 lists water quality guidelines for the tree and vine crops most commonly grown in California. These guidelines assume that the soil is well-drained — that is, that adequate soil aeration exists for root respiration and disease control— and that the leaching fraction is 0.15. Under these conditions the relationship between average rootzone salinity (ECe) and ECw is ECe = 1.5 ECw. It is also assumed that all other factors (such as fertility, irrigation scheduling, and pest control) are managed for optimal crop performance. The ECw values given in the table represent the maximums that can be continuously used to achieve the given yield. For example, the ECw values at 100% yield represent the poorest quality water that, if used continuously, will produce ECe levels equal to the salinity thresholds.

Toxicity to Specific Elements

Unlike most annual crops, tree and vine crops are generally susceptible to boron and chloride toxicity. Tolerances vary among species and rootstocks. Tolerant varieties and rootstocks restrict the uptake and accumulation of boron and chloride in leaf tissue. Boron concentrations in the irrigation water exceeding 0.5 to 0.75 mg/L can reduce plant growth and yield. Climatic effects are also important. In the cool moist coastal climates, irrigation waters with boron concentrations exceeding 1 mg/L are used successfully on tree and vine crops.

Short-term Versus Long-Term Use of Water

These guidelines are based on the long-term use of the given water quality. Poorer quality water can be tolerated if used on a short-term basis.

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If good quality water is used for one-third of the irrigation season, saline water with an ECw that would cause a 25% to 50% yield reduction if used continuously (Table 1) may be used for the remaining season with little or no yield reduction. Caution is advised in using this irrigation strategy since reduced growth and increased levels of chloride and boron in the soil and plant tissue could reduce yields in future years. Sufficient rainfall or good quality water is needed the subsequent year to leach most of the salts from the upper two or three feet of the rootzone. In some soils, good quality water following saline water could cause reduced soil-water infiltration, creating an ideal environment for root diseases.

Table 1. Estimated crop yield using irrigation water of different qualities over the long term.(Potential yields are based on a 15% leaching fraction and do not take into account specific element effects.)

	Yield Potential (%)[1]				Rating[2]
Tree and Vine Crops	*100*	*90*	*75*	*50*	
	..... ECw (mmhos/cm).....				
Almond[3]	1.0	1.4	1.9	2.8	S
Apricot[3]	1.1	1.3	1.8	2.5	S
Blackberry	1.0	1.3	1.8	2.5	S
Boysenberry	1.0	1.3	1.8	2.8	S
Date Palm	2.7	4.5	7.3	12.0	T
Grape[3]	1.0	1.7	2.7	4.5	MS
Grapefreuit[3]	1.2	1.6	2.2	3.2	S
Orange	1.1	1.6	2.2	3.2	S
Peach	1.1	1.5	1.9	2.7	S
Plum(prune)[3]	1.0	1.4	1.9	2.9	S

1. Based on data from E.V. Maas. 1990. "Crop salt tolerance," in *Agricultural salinity assessment and management*, ed. K.K. Tanji. ASCE Manual No. 71. ASCE.
2. Sensitive (S), moderately sensitive (MS), moderately tolerant (MT), and tolerant (T) to soil salinity.
3. Tolerance is based on growth rather than yield.

Table 2. Maximum salinity concentrations that various tree and vine crops can tolerate without develoing leaf burn. (Assumes long-term effects and a 15% leaching fraction.)

Crop	*Rootstock or cultivar*	*Maximum Recommended Salinity Concentrations*[a]	
		ppm	*meq/L*
Avocado	West Indian	180	5.07
(Persea Americana)	Guatemalan	140	3.94
	Mexican	120	3.38
Citrus	Sunki Mandarin, Grapefruit, Cleopatra mandarin, Rangpur lime,	590	16.62
	Sampson tangelo, rough lemon[b], sour orange, Ponkan mandarin	350	9.86
	Citrumelo 4475, trifoliate orange, Cuban shaddock, Calamondin, sweet orange, Savage citrange, Rusk citrange, Troyer citrange	240	6.76
Grape	Salt Creek, 1613-3	950	26.76
(Vitis spp.)	Dog ridge	710	20.00
Stone fruit	Marianna	590	16.62
(Prunus spp.)	Lovell, Shalil	240	6.76
	Yunnan	180	5.07
	Cultivars		
Berries[c]	Boysenberry	240	6.76
(Rubus spp.)	Olallie blackberry	240	6.76
	Indian Summer raspberry	120	3.38
Grape	Thompson seedless, Perlette	470	13.24
(Vitis spp.)	Cardinal, black rose	240	6.76
Strawberry	Lassen	180	5.07
(Fragaria spp.)	Shasta	120	3.38

a. These concentrations may exceed the salinity threshold and cause some yield reduction in some crops.
b. Data from Australia indicates that rough lemon is more sensitive than sweet orange to Cl^-.
c. Data available for one variety of each species only.

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